MINING APPLICATION

No._____

Date_____

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING
1588 West North Temple
Salt Lake City, Utah 84116

Original

MINING AND RECLAMATION PLAN

A. Applicant - Kennecott Copper Corporation, Utah Copper Division.

B. Type of Operation - Mining and processing for mineral extraction. Mining method and processing facilities are continually modified and updated to meet natural and physical requirements and conditions of market, technology, governmental regulation, economics and other factors. Large scale mining operation has been underway since about 1904. Remaining life of the mining operation will depend upon many things including the likelihood that eventual mineral shortages and improved technology will justify mineral extraction from materials now considered waste. It is, therefore, impossible to predict a terminal point for the mining and processing operations. However, it is not expected that this terminal point will occur within the next 50 years.

The Utah Copper Division operations extend from in and around the Bingham mine to just beyond the north end of the Oquirrh Mountains near Magna (see CONFIDENTIAL map, Exhibit A). The operation is divided into the following areas which are

identified on Exhibit A, shown in schematic arrangement on process diagram Exhibit B, and covered separately herein:

1. Mine
2. Mine Waste Disposal
3. Excess Mine Water Disposal
4. Ore Transfer - Mine to Process
5. Ore Processing Facilities
6. Tailing Disposal
7. Excess Process Water Disposal

1. Mine Area

The mine area from which overburden and ore is removed comprises approximately 3100 acres.

Prior to open pit mining which began in 1904, this mountainous area had been a source of timber and was being used for underground mining operations with associated surface facilities, residences, businesses, etc. As open pit mining has expanded, these other uses have been discontinued.

Determination of a definite use for the area after mining operations cease is nearly impossible due to many uncertainties involved. Some possibilities may include:

Scenic attraction.

Historical landmark.

Other public or private use.

Very little vegetation remains in the mining area because of the considerable volume of material having been displaced. The remaining vegetation consists of grasses, forbs, shrubs, and trees such as aspen, mountain mahogany, Utah juniper and

fir. The pH of undisturbed soils range from 4.5 to 7.5 as determined by mixing 100 gm of soil with 100 ml of distilled water. Most materials removed from or exposed in the mine are acidic. Surface elevation ranges from approximately 5240 feet to over 7800 feet above sea level.

Underground workings and natural bedrock aquifers have been, and will continue to be, encountered during mining operations. The drainage from these abandoned mines and fault-related aquifers is discharged through a railroad tunnel to supply make up water for leaching operations. At times the water is bypassed by pipeline and canal to a disposal area (see Area 3.) Typical analysis of this water is listed below:

pH	4.7	Fe	100 ppm
TDS	2,400 ppm	Cl	70 ppm
SO4	1,400 ppm	Ca	500 ppm
Al	5 ppm	Cu	4 ppm
Mg	50 ppm		

Experiments are being conducted to determine if this water can be used for irrigation.

Since open pit mining began, over 1,350,000,000 tons of ore and 2,400,000,000 tons of waste have been removed. This is one of the largest mining operations ever undertaken, having produced more copper than any other mine in history. The present excavation is approximately 2-1/4 miles wide and 1/2 mile deep (see photograph Exhibit C). There are now 56 levels or benches in the mine which typify open-pit mining, a feasible and economical system for handling the low grade ore and overburden in vast quantities. Height of the benches ranges between 40 and 50 feet. Material is now being removed from 20 lower benches by rail and from

upper benches by truck. Approximately 200 miles of roads and railroads are in use in the mine area.

The ore body is in the shape of a plug, or an inverted cone. As the mine progressively develops in depth, all benches must be pushed farther and farther back to gain necessary operating space and assure safety by maintaining a stable slope ranging between 25° and 29° from horizontal.

The mining sequence includes drilling, blasting, loading by shovel and haulage by trucks, waste cars and ore cars. At the present time, approximately 108,000 tons of ore and 380,000 tons of waste are removed during each operating day. Ore is transported by rail to process plants and waste is deposited in outlying areas of the mine (see Area 2). Equipment size continues to increase through improved materials and technology. Haulage trucks now in use at the mine range in capacity from 65 tons to 150 tons. Shovels range from 6-yard to 25-yard capacity.

It is expected that in the future other mining methods such as underground mining and in-situ extraction may become economically feasible and practiced for recovery of lower lying minerals in the Bingham mine area.

It is impossible to perform any revegetation as open pit mining progresses because the total area is continually being disturbed. At the conclusion of open pit mining, sides will be stabilized at a slope in the range of 32° to 37° from horizontal. It is very unlikely that the pit could be revegetated at that time because most of the exposed

surface will be solid rock containing natural sulfide mineralization. Meteoric water and atmosphere will generate acidic conditions from these minerals. Covering the surface with soil would not be economically feasible and would require disturbance of a considerable surface of other area to provide a source for the soil cover. The bottom of the pit may eventually fill with water; however, the level can be limited by discharge through one of the available railroad tunnels. Such discharge water would either be processed for mineral extraction and neutralization, impounded, used for other acceptable purposes or otherwise safely disposed of as may be determined in the future.

Surface facilities including buildings, railroad tracks, power lines and poles and equipment will be razed or removed from the mine area when no longer needed in the mining or subsequent operations.

2. Mine Waste Disposal Area

Waste material or overburden removed from the mine is deposited in outlying areas in Bingham Canyon, on the east front of the Oquirrhs and in Butterfield Canyon. Total area comprises approximately 8000 acres, leaching and precipitation operations are conducted for recovery of minerals from this waste material.

Prior to use for waste disposal the area ranged in elevation from 5200 feet to 7900 feet above sea level and had been a source of timber, was used for dry farming, grazing, and underground mining with associated surface facilities, resi-

dences, business, etc. These uses have been discontinued as waste material has covered the area. However, some grazing and dry farming continues on low lying perimeter areas.

It is expected that leaching and precipitation operations and possibly other processing methods will be used for mineral extraction from the dumps long after final deposition of mine waste is completed. Some possible ultimate uses of the area may include:

A source of borrow and granular material.

Residential, commercial or industrial development.

Recreational.

Scenic.

Other.

Little or no vegetation exists on areas covered by waste dumps. Vegetation on area that will eventually be covered consists of grasses, forbs, shrubs and trees such as juniper, mountain mahogany and maple. The pH of undisturbed soils range from 4.5 to 7.5 as determined by mixing 100 gm of soil and 100 ml of distilled water. Waste dumps tend to become acidic from meteoric water and atmosphere and from the leach solutions (pH 3 - 3.5) that are distributed over the dumps.

The leaching and collection system including the protection against escape of leach water from waste dumps into lower lying areas is shown in schematic arrangement on Exhibit D. It consists of reservoirs, pumps and piping to distribute

solution on the dumps, pipelines from dams to the precipitation plant and an overflow canal to collect and convey any escaping solution to the reservoir. Leach solution is processed at the precipitation plant for mineral recovery. During extremely wet or high runoff period, excess leach solution may accumulate in the reservoirs and require discharge to the Excess Mine Water Disposal Area (Area 3).

As noted under Area 1, waste dumps presently comprise approximately 2,400,000,000 tons of material and are increasing at the rate of 380,000 tons per day. Waste is transported from the mine by trucks and rail cars and is dumped over the banks to a natural angle of repose. Rail dumps are terraced at approximate 100 foot levels which progress out generally in a uniform manner. Truck dumps are higher and are extended out at the same level without terracing. Problems in dump stability have been encountered on some large truck dumps which are generally associated with inadequate foundation material underlying the dumps. Slides have occurred from failure of this underlying or foundation material. However, because these dumps are active, no attempt is needed to stabilize these areas other than monitoring and precautionary systems for safety. Movement detection switches and movement noise detectors have been installed to detect any dump movement prior to failure. These systems will continue to be maintained and improved as mining progresses. In addition, computer models have been developed to simulate conditions in dumps to estimate the position of the dump crest when stability becomes critical. In the future, control points or a survey

net may be established to check dump movement and settlement. After dumps become inactive for dumping, other stabilization may be tested and implemented. These techniques would probably include terracing and hydraulic methods consistent with subsequent use determined at that time. Collection systems will be retained to contain natural seepage in the area. Dikes and ponds will be constructed on the upper levels of dumps to prevent slope wash and possible mud slides.

No major revegetation is planned because the majority of the waste material contains natural sulfide mineralization which becomes acidic when exposed to meteoric waters and the atmosphere. However, in some small areas of the dumps where there is little or no sulfide mineralization, tests are being conducted to determine possible methods and types of vegetation suitable for these areas. These tests include aerial seeding of approximately 20 acres with grasses, forbs and shrubs, and hand planting of a two acre control area for more detailed study which is being conducted jointly with the U.S. Forest Service. When no longer needed in the mining, mineral extraction or subsequent operations, all surface facilities, including buildings, above ground utilities, railroads, piping and equipment will be razed and/or removed. Much of this type effort has been accomplished in the past, including demolition of buildings in the city of Bingham Canyon, removal of trackage from old rail dumps, and removal of bridges in Carr Fork and other demolition and clean up work.

3. Excess Mine Water Disposal Area

This involves an approximate 2700 acre area upon which excess mine water is transported and contained in ponds for evaporation. Facilities may be installed at a later date for treatment of water prior to disposal.

Prior to use for excess mine water disposal which commenced in 1935, the land was used for grazing and dry farms. After construction of the Bingham Creek reservoir at the mouth of Bingham Canyon in 1965, discharge to the evaporation pond area was considerably reduced and now required only during extremely wet or high runoff periods. Currently, much of the land is used for dry farming and sand and gravel operations.

Possible future uses of the land when no longer needed in the mining operation may include one or more of the following:

Sand and gravel operations.

Farming.

Water storage and evaporation.

Recreational.

Water or sludge disposal by others.

Residential, commercial or industrial development.

Other.

In addition to dry-farm wheat, the area contains natural grasses, forbs and shrubs. The pH of the natural soils range from 6.5 to 7.5 as determined by mixing 100 gm of soil and 100 ml of distilled water. Surface elevation ranges from approximately 4675 feet to 5200 feet above sea level.

Residues of evaporation are acidic and contain soluble ions of iron, aluminum, magnesium and sulfate. Depending upon specific source of excess water from mine operation, water analysis will range between the following values:

pH	4.7 - 3.2	Fe	100 - 2,400 ppm
TDS	2,400 - 6,700 ppm	Cl	70 - 180 ppm
SO_4	1,400 - 52,000 ppm	Ca	400 - 500 ppm
Al	5 - 4,600 ppm	Cu	4 - 100 ppm
Mg	50 - 6,300 ppm		

Evaporation ponds are contained and separated by dikes constructed of earth from the area. Dikes are approximately four feet high and twelve feet wide on top. Side slopes are approximately two horizontal to one vertical. Dikes are monitored and maintained to prevent spill of solution.

At such time as area is no longer needed for excess water disposal or other purposes associated with mining operation, stabilization will be accomplished consistent with subsequent use determined at that time. This may include removal or covering accumulated salts, treatment with neutralizer, grading and revegetation work. In any event, area will be left in safe, stable condition suitable for future use and without hazard of erosion or surface water accumulation.

Because the area appears better suited for future uses in farming than other vegetative purposes, any revegetation work would most likely be accomplished to suit farming requirements. In the event of farming, or soil stabilization, this would involve testing by standard agricultural analysis (e.g. Utah

State Soils Laboratory), application of fertilizer, and cultivation. Such crops as wheat, barley, alfalfa, wheatgrass and clover could be raised. Irrigation could be considered if sufficient water becomes available.

4. Ore Transfer - Mine to Process Area

From the mine area at Bingham, ore is transported to the processing plants near Magna by railroad cars. This railroad line of approximately 15 miles crosses generally through slightly sloping land near the base of the Oquirrh Mountains. Total area of this railroad right-of-way is approximately 400 acres.

Land along the railroad is used primarily for dry farming. It may have been previously used for grazing.

When no longer needed in the mining operation, the railroad may be used to serve future industrial or commercial needs. Otherwise, the railroad right-of-way will have potential use for:

Residential, commercial or industrial development.
Utility right-of-way.
Roadway.
Other.

In addition to dry farm wheat, the area contains natural grasses, forbs and shrubs. The pH of the soils range from 6.5 to 7.5 as determined by mixing 100 gm of soil and 100 ml of distilled water. Surface elevation ranges from approximately 5400 feet to 4500 feet above sea level.

At such time as the railroad is no longer needed in the mining or processing operations or for subsequent use, trackage and surface facilities will be removed and area left in condition suitable for conversion to other use determined at that time.

Revegetation of the disturbed area does not appear to be warranted because value for other use and development should be considerably greater than achievable by attempt to return the area to a natural condition.

5. Ore Processing Facilities Area

Over the years ore processing facilities have been added, changed, enlarged and improved to suit needs and conditions. Many more such modifications are expected in the future. Facilities now consist of the Arthur, Magna and Bonneville concentrators, power plant, railroad car and engine shops, lime plant, foundry and other supporting and related surface structures and utilities. Total land area comprises approximately 1600 acres. Other separated facilities include water supply and distribution systems and maintenance shops. This represents a total additional area of approximately 200 acres.

Prior to use for ore processing, this area on the north foothills of the Oquirrh Mountains would have had no known use other than very limited grazing.

Possible future uses of the area when no longer needed for ore processing may include one or more of the following:

Other industrial or commercial operations.

Residential.

Other public or private use.

Prior to construction of initial process facilities in about 1906, vegetation consisted of natural grasses, forbs and shrubs such as sagebrush, oak, service, mahogany and juniper. Most of this vegetation remains in undisturbed portions of the area. Other vegetation has been added for stabilization and appearance. This includes trees such as Russion olive and Chinese elm and plants such as alfalfa, clover and various grasses. The pH of natural soils range from 6.5 to 7.5 as determined by mixing 100 gm of soil and 100 ml of distilled water. Surface elevation ranges from approximately 4200 feet to 5400 feet above sea level.

At such time as the surface facilities, including buildings, utilities, railroads, equipment, etc., are no longer needed for ore processing or related purposes and if not convertible to some other use, they will be razed and/or removed. All hazardous conditions will be eliminated and ground surfaces stabilized and planted as needed using vegetation types natural or subsequently determined to be best suited to the area.

6. Tailing Disposal Area

Tailing produced from the ore concentrators is discharged as a slurry into a 6000-acre tailing pond adjacent to and north of the concentrators. The original ground surface which ranged in elevation from 4210 feet to 4340 feet above sea level is believed to have been a sparsley vegetated, highly alkaline soil such as present perimeter areas. Prior to use for tailing disposal which began about 1916 some limited livestock grazing may have been attempted.

In its terminal condition for deposition, the tailing pond may be considered as a resource. It will contain unrecovered minerals that eventually may justify reprocessing for recovery. Tailing material also has value as fill for land reclamation and construction such as currently used for highway embankment work. Studies have demonstrated that mixing tailing material with alkali soils enhances capability of sustaining a wide range of vegetation. Considerable areas of Western Utah and in Nevada may be reclaimed for agricultural and other purposes by this material.

When no longer needed for foregoing purposes, the tailing disposal area will have potential use for one or more of the following:

Farming.

Recreational.

Scenic Attraction.

Residential, commercial or industrial development.

Other.

Natural vegetation in the area includes salt grass, wire swamp grass, cat tails and salt bush. The pH of the natural soils range from 8.5 to 9.0 as determined by mixing 100 gm of soil and 100 ml of distilled water. High clay content of the soil, close proximity to Great Salt Lake and poor drainage would have contributed to the highly alkaline condition.

The tailing pond is a continually rising area (currently rising at about $3\frac{1}{2}$ feet per year) and is contained by a dike which extends completely around its perimeter. This dike must also be continually raised and be maintained in a stable condition. Initially, dike fill was rock waste from the mine, later hauled fill from areas adjacent to the concentrator plants was used, and more recently, dike build up is being accomplished by relocation of previously placed dike fill material by drag line. This is followed by sealing of the pond side of the dike with a berm of coarse tailing distributed by a perimeter pumping system. To obtain adequate dike stability, the outside of the dike is maintained at 5 to 1 slope as recommended by consultants on slope stability. Periodic inspections are conducted by consultants to assure long range stability of the system. Present elevation of the pond surface averages approximately 4345 feet above sea level. Dewatering of the tailing pond is by means of two buoy-supported siphon lines which remove clear water, most of which is reclaimed as concentrator process water.

The area near the top of the dike which is subject to being disturbed in the subsequent dike build up, and roads on the dike, are stabilized to prevent wind erosion by frequent application of a soil stabilizing agent such as Coherex. Farther down the outside slope where the surface is permanent, revegetation is practiced. Current plantings include several plant and tree species along the dike slopes. Success has been achieved with Japanese millet, rye, yellow sweet clover, wheatgrass, brome, range alfalfa and vetch plants and Russian olive, larch and elm trees. Because of the continually rising tailing deposition, permanent stabilization or revegetation of the pond surface is not possible as long as operation continues. However, wind erosion control is practiced. About 90% of the pond surface is kept moist at all times by the natural meandering of the tailing stream discharged into the pond. The remaining areas are treated by several different methods to stabilize the surface. Where possible, the surface is wetted by tailing distribution lines installed for this purpose. If this is not feasible and the dry areas are accessible to land vehicles, the surface is treated with stabilizing agents. If not accessible by land vehicles, dry areas are treated by application of a polymer product with aircraft. Use of fast growing grasses is also being investigated for wind erosion control.

Based upon current operating rates and practices, by the year 2025 the tailing pond surface area will be reduced to approximately 3,000 acres and the average elevation will be approximately 4560 feet above sea level.

When no longer needed for tailing deposition, mineral recovery or material source, grading and revegetation of dike slopes not already done will be completed. Drainage will not be a problem. As noted previously, the outer surface of the dike will have an average 5 to 1 slope. The pond surface will have, or will be graded to, a natural slope which will be more than adequate for drainage needs, considering that this is a region of low precipitation and the surface can adequately absorb normal precipitation.

Revegetation is also receiving consideration by Kennecott and other mining companies for stabilization and subsequent reclamation of inactive tailing pond surfaces. To this end, test work is being conducted to ascertain which species of vegetation are suitable, and procedures required to obtain adequate vegetation growth. Planting Japanese millet at the rate of 10 to 15 pounds per acre with fertilizer may be a means of vegetating the tailing pond surface after deposition is completed and to a limited extent during the deposition process.

7. Excess Process Water Disposal Area

This comprises a treatment plant, sludge disposal area, canals and diversion facilities now existing as well as possible additional treatment facilities, water storage and evaporation ponds and other facilities that may be required in the future. It involves perimeter areas around the tailing disposal area (Area 6) comprising a total of approximately 1000 acres.

Most of the area remains in a natural state and may have been used for very limited grazing prior to the early 1900's.

Possible future uses of the area when no longer needed for water treatment and disposal may include one or more of the following:

Other industrial or commercial operations.

Residential development.

Other public or private use.

Natural vegetation in the areas includes salt grass, wire swamp grass, cat tails and salt bush. The pH of the natural soils range from 8.5 to 9.0 as determined by mixing 100 gm of soil and 100 ml of distilled water. The area is comparable to the original ground surface of the tailing disposal area. Surface elevation ranges from 4210 feet to 4300 feet above sea level.

Canals have been constructed around the tailing pond area to convey natural flows and drainage and excess water from tailing pond and treatment plant to the Great Salt Lake. Sludge from the treatment plant is deposited in a low diked area.

At such time as the surface facilities including treatment plant, piping and utilities are no longer needed and if not convertible to some other use, they will be razed and/or removed. Sludge ponds, evaporation ponds and possibly other areas will likewise be left in condition suitable for conversion to other use determined at that time. This may

involve filling or covering with tailing and other stabilization and revegetation work comparable to that designated for the tailing disposal area. Canals will most likely be left indefinitely for conveyance of natural surface flows and drainage to Great Salt Lake.

CIRCULATE TO:
DIRECTOR
PETROLEUM ENGINEER
MINE COORDINATOR
ADMINISTRATIVE ASSISTANT
ALL
RETURN TO LuAnn Corbett
FOR FILING

May 11, 1976

MEMO TO FILE:

Re: Kennecott Open Pit Mine

The Kennecott Mine was inspected on May 3, 1976 by the Division of Oil, Gas & Mining staff. Guides for the tour were Charles Stillman, Planning Engineer; William Southard, Mines Plant Superintendent; and Joe Ribotto, Process Central and Improvement Superintendent of the Arthur Concentrator.

An inspection of the open pit mine itself was made first, this was followed by looking at ancillary facilities to the mine and an overburden leaching operation, and the stabilizing efforts being made on several abandoned evaporation ponds were also observed.

Mine work is progressing as space and ownership allows around the existing pit. Slope inclination generally follows a 4:1 gradient for the total mine. That is, for every 100 feet of depth at the pit bottom, 400 feet must be excavated horizontally. Waste rock can be moved from the pit by rail, through tunnels to the rail waste dump and by 150 ton trucks. Both dumping areas are on the west side of the Salt Lake Valley and are forming a true "West Bench" in the valley. The railroad dumps have proved to provide a more stable surface than truck haul dumps.

Leachate from the dumps is processed in a precipitate plant near the town of Copperton and comprises roughly 17% of the total copper produced.

Hundreds of acres of ancillary facilities, maintenance shops, and water pumping stations dot the general area of the mine.

The widespread nature of the operations about the mine and in Bingham Canyon would make a finely detailed reclamation plan somewhat impractical at this time. Stabilization of the now unused evaporation ponds below the mine in the Salt Lake Valley itself is being attempted through clover, tall wheat grass, and barley planting. Windbreaks are also being utilized to help contain wind blown sand and dust.

Reclamation plans for the stabilization of abandoned facilities and those which will be used one time only can be formulated at this time. For example, the specifics of stabilizing the evaporation ponds can be formed now. For the active operations the reclamation plans should be put together now, but in the way of objectives for each phase. This type of approach would outline plans to achieve the desired results but not necessarily be binding as for the means of achieving the results.

DIVISION OF OIL, GAS & MINING

RONALD W. DANIELS
COORDINATOR OF MINED
LAND DEVELOPMENT

RWD/lm